

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Devendra T. BAROT	§	Confirmation No.: 6462
Serial No.:	09/482,023	§	
Filed:	January 13, 2000	§	Group Art Unit: 1764
For:	Combustion Chamber Design for a Quench Gasifier	§	Examiner: Basia Anna Ridley

APPEAL BRIEF

Mail Stop Appeal Brief – Patents

Date: April 4, 2005

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

Appellant hereby submits this Appeal Brief in connection with the above-identified application. A Notice of Appeal was filed on March 23, 2004.

I. REAL PARTY IN INTEREST

The real party in interest is the Applicant named in the caption above.

II. RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any related appeals or interferences.

III. STATUS OF CLAIMS

Originally filed claims: 1-9.

Added claims: 10-40.

Withdrawn claims: 22-29.

Cancelled claims: 1-9, 11-14, 16, 21, 30, 33 and 36.

Presently rejected claims: 10, 15, 17-20, 31, 32, 34, 35 and 37-40.

Presently appealed claims: 10, 15, 17-20, 31, 32, 34, 35 and 37-40.

IV. STATUS OF AMENDMENTS

Since the Examiner's last rejection on December 23, 2003, Applicant filed a drawing amendment on April 1, 2005, including two Replacement Sheets adding the label "Prior Art" to Figures 1 and 2. It is Applicant's understanding that the Examiner intends to enter the April 1, 2005 drawing amendment. No other amendments have been filed by Applicant subsequent to the Examiner's last rejection dated December 23, 2003.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The various embodiments of the three independent claims (10, 34 and 37) are directed to a quench gasifier for gasifying hydrocarbon feedstocks such as residual oils, waste lubrication oils, petroleum cokes and coal. *Specification* (attached as Appendix B), p. 1, ll. 15-16. Appellant's drawing Figure 3 illustrates exemplary embodiments and is reproduced on the next page for convenience of discussion. All Figures are appended hereto as Appendix D.

With reference to Figure 3, first independent claim 10 defines a quench gasifier for gasifying ash-containing hydrocarbon feedstocks comprising: a combustion chamber (*Specification*, p. 1, ll. 20-24; p. 4, ll. 8-11; Fig. 3, "Combustion Chamber"); and a quench chamber adjacent to said combustion chamber (*Specification*, p. 1, l. 25 – p. 2, l. 7; Fig. 3, "Quench Chamber"), said combustion chamber including a throat adjacent to said quench chamber (*Specification*, p. 2, ll. 2-3, ll. 8-18; p. 4, ll. 9-15; Fig. 3, "Gasifier Throat"), characterized in that said throat includes: an inlet adjacent to said combustion chamber, said inlet having an inlet diameter (*Specification*, p. 5, ll. 9-14; Fig. 3, "D₁"); an outlet adjacent to said quench chamber, said outlet having an outlet diameter (*Specification*, p. 5, ll. 9-14; Fig. 3, "D₄"); an inner surface and outer surface between said inlet and said outlet (*Specification*, p. 3, ll. 15-18; p. 5, ll. 1-7; Fig. 4, "Inner Shape" and "Outer Shape"); an electrical heating element between said inner and outer surfaces (*Specification*, p. 5, ll. 1-5; Figs. 3 and 4, "Heating Element"); and wherein said inlet diameter is greater than said outlet diameter (*Specification*, p. 5, ll. 9-14; Fig. 3, "D₁" and "D₄").

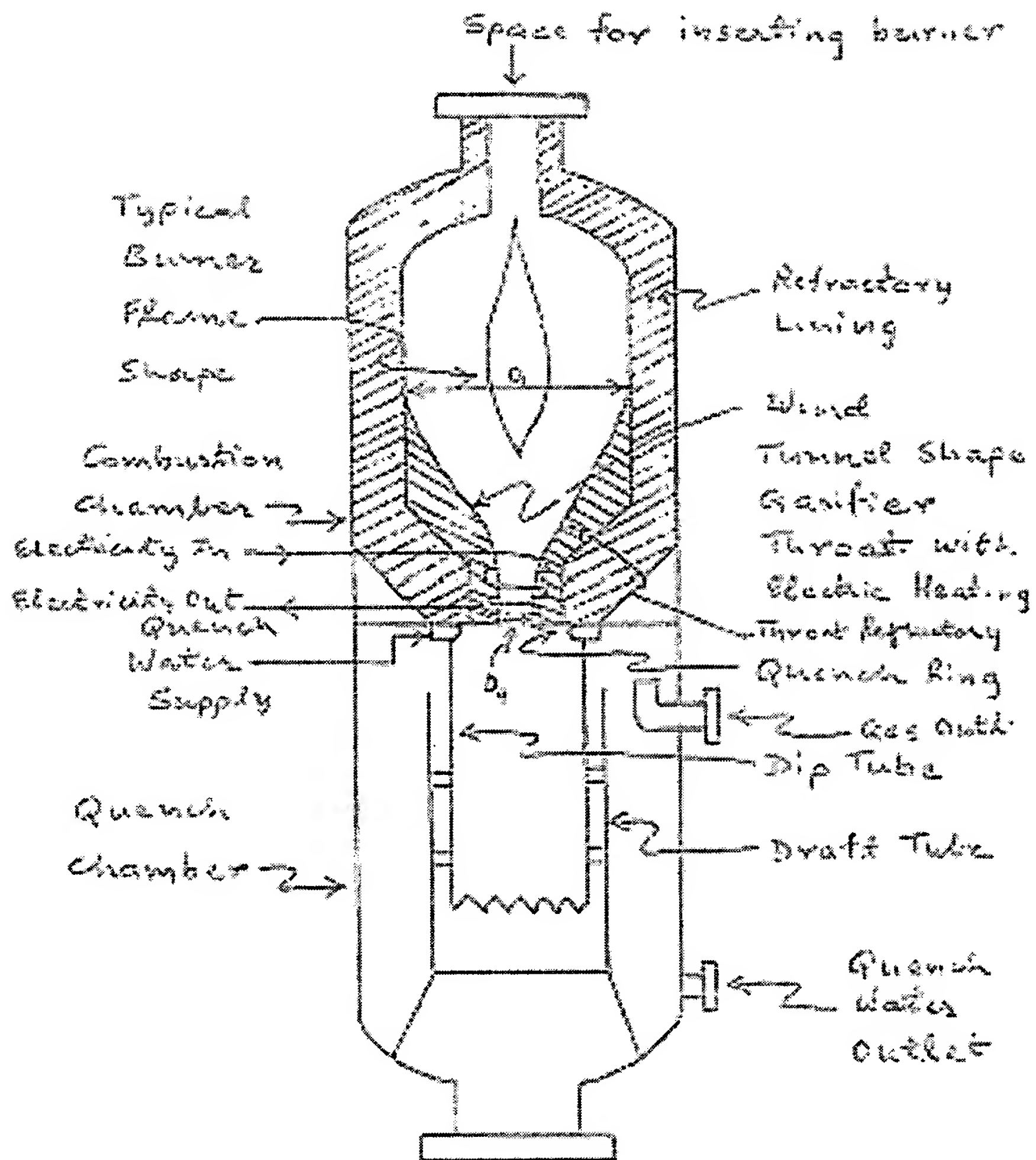


Figure 3

Similar to claim 10, claim 34 recites a quench gasifier comprising a combustion chamber and a quench chamber, wherein said combustion chamber includes a throat having an inlet, an outlet, an outer surface, an inner surface and a heating element between said two surfaces. Further, claim 34 recites an inner

surface having a curved, conical contour (*Specification*, p. 3, ll. 10-12; p. 4, ll. 6-15; p. 5, ll. 9-14; Figs. 3 and 4).

Claim 37 recites identical structure to claim 10 except for the deletion of "wherein said inlet diameter is greater than said outlet diameter," and the addition of an electrical heating element "configured to maintain said inner surface at a temperature of at least 3000°F" (*Specification*, p. 2, ll. 21-22; p. 3, ll. 12-13; p. 5, ll. 1-7).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The Examiner's first ground of rejection includes the assertion that pending claims 10, 15, 17-20, 34 and 37-40 are rendered obvious by Appellant's Admitted Prior Art (*Specification*, p. 1 and 2, Figures 1 and 2) in view of *Takada et al.* (JP 61-222939) (hereinafter called "*Takada*," translation attached as Appendix C). The Examiner asserts that it would have been obvious to one having ordinary skill in the art to add the simple trough heating element of *Takada* to the more complex quench gasifier of Figures 1 and 2, and, more particularly, to add the heating element in the throat region of the gasifier.

The Examiner's second ground of rejection includes the assertion that pending claims 31, 32 and 35 are rendered obvious by Appellant's Admitted Prior Art in view of *Takada* and in further view of *Haneda et al.* (JP 61-235492) for similar reasons.

VII. ARGUMENT

A. First Ground of Rejection: Prior Art in view of *Takada*

Claims 10, 15, 17-20, 34 and 37-40 have been rejected according to the Examiner's first ground of rejection. Applicant feels the arguments below apply to all of these claims. However, Applicant feels claims 37-40 are allowable for an additional reason, and will be addressed under a separate heading below.

1. Claims 10, 15, 17-20 and 34

Claims 10, 15, 17-20 and 34 are all limited by a heating element disposed between the inner and outer surfaces of the gasifier throat. The gasifier throat is part

of a large and complex quench gasifier intended for dramatically heating and gasifying hydrocarbon feedstocks to produce, most importantly, synthesis gases (syngas) and, as a by-product, slag. The present specification teaches that a heating element may be placed in the throat of a quench gasifier to prevent plugging of the throat outlet area, to increase syngas production and carbon conversion without increasing oxygen and steam consumption, and to decrease the capital cost and improve reliability of the gasifier operations by eliminating the need for a soot recycle system and streamlining the heat-generating capabilities of the gasifier.

Takada discloses a trough for running slag generally horizontally, *i.e.*, for simply transporting slag and not for the complex treatment and processing of feedstocks, syngas and slag. The *Takada* trough stands alone and is open at the top, thereby exposing the trough's contents to ambient surroundings.

Takada is directed to the production of a high quality rock wool, and addresses the specific problem of displacement of the falling location of slag due to a slag coating that may occur at the "tip" of the trough. The displacement affects the quality of the final product. *Takada*, p. 2, 3rd para. Preventing the slag coating and, thereby, stabilizing the falling point of the slag ensures production of a high quality rock wool. *Takada*, p. 4, 1st para. *Takada* describes how the slag is created in "cupolas," or combustion gasifiers, and transported from the cupolas via a trough. *Takada*, p. 2, 1st para. *Takada* identifies the contact surface of the trough as a location where the slag coating may occur, and makes no reference to other locations where the slag coating, or slag solidification, is a problem.

Applicant submits that the Examiner has failed to make out a *prima facie* case of obviousness because a) there is no motivation to make the combination in the Examiner's first ground of rejection, and b) there is no reasonable expectation of success for the proposed combination.

a) No Motivation to Combine

Appellant's Admitted Prior Art does not show a throat including an electrical heating element between the throat's inner and outer surfaces. Nor does Admitted

Prior Art suggest heating a combustion gasifier throat. *Takada* does not show a combustion gasifier throat including an electrical heating element between the throat surfaces. Furthermore, *Takada* does not suggest the claimed element of a heating element disposed in a gasifier throat, or modification of the Admitted Prior Art gasifier to include the claimed element.

No "Express" Motivation

Neither Admitted Prior Art nor *Takada* include an express motivation to make the proposed combination. As alluded to above, an express motivation may include a suggestion to heat the throat in some way, for example, or some other suggestion of the desirability of the proposed combination. Admitted Prior Art does not make such a suggestion. *Takada* likewise lacks an express motivation because, despite recognizing the existence and purpose of a copula, or gasifier, *Takada* makes no mention of slag coatings in the copula, nor does it suggest heating a portion of the copula, including a throat. The sparse *Takada* disclosure does not contemplate gasifier design, throat or otherwise, and makes no suggestion of the applicability of the disclosure to any subject matter outside of a horizontal trough used to transport slag. In other words, it is not known from the *Takada* disclosure that slag solidification is a problem outside of a trough exposed to ambient surroundings and used to transport slag.

Lack of an express motivation to combine has been said to be suggestive of impermissible hindsight reasoning. See MPEP § 2145. Although an express motivation is not required, the Examiner's burden increases when such an express motivation cannot be found. In the absence of an express motivation to combine, the Examiner's sole thrust of her first ground of rejection is in the nature of the problem to be solved, *i.e.*, slag solidification. To this issue, the Federal Circuit has held that when the required motivation to combine is found in the nature of the problem to be solved, this is simply a conclusory assertion lacking the clear and particular showing needed for a motivation to combine. The showing must be supported by actual evidence. See *Teleflex, Inc. v. Ficosa North America Corp.*, 299

F.3d 1313, 1334 (Fed. Cir. 2002). The Examiner's broad, conclusory assertion that the nature of the problem to be solved, *i.e.*, slag solidification, provides the requisite motivation to combine does not meet the Federal Circuit's clear and particular standard of the showing necessary to combine Admitted Prior Art with *Takada*. This requirement of evidencing a suggestion by the prior art to combine is rigorously enforced to avoid the dangers of impermissible hindsight.

As evidence that the Examiner has not made a clear and particular showing to make the proposed combination, the slag solidification problem of Admitted Prior Art and the slag solidification problem of *Takada* are incongruous. The slags contemplated by Admitted Prior Art contain vanadium trioxide (V_2O_3) or other metals or metal compounds that solidify at temperatures lower than 3000°F, thus requiring heating the throat of a gasifier combustion chamber to at least 3000°F for the purpose of preventing slag solidification. *Specification*, p. 2, ll. 14-16; p. 4, ll. 16-21. *Takada* does not contemplate a temperature high enough or environment suitable to prevent solidification of slags containing vanadium trioxide (V_2O_3) or other metals that solidify at temperatures lower than 3000°F. *Takada* teaches preventing slag solidification at 1472°F, less than half of the minimum preferred (3000°F) by the description in the specification. The slags considered by each reference are different, therefore the nature of the problem to be solved alone does not satisfy the Examiner's burden.

**The Proposed Modification Cannot Render the Prior Art
Unsatisfactory for Its Intended Purpose**

A motivation to combine prior art references also does not exist when the proposed modification renders the prior art unsatisfactory for its intended purpose. See MPEP § 2143.01. *Takada* teaches pre-heating a trough to 1000°C (1832°F), then decreasing the temperature until the operation (running the slag) is performed at 800°C (1472°F). *Takada*, pp. 4-5. The intended purpose of operating the trough under these conditions is to provide a temperature high enough so that the slag will not solidify, thereby preventing generation of a slag coating and ensuring production

of a high quality rock wool. *Takada*, pp. 2-5. Therefore, *Takada* describes the stand-alone environment of a trough, which is not suggested to be any part of a gasifier or other reactor, that provides an operating temperature of 1472°F.

The present specification describes heating the throat of a gasifier combustion chamber to at least 3000°F for several purposes: 1) preventing slag solidification, especially those slags containing vanadium trioxide (V_2O_3) or other metals or metal compounds that solidify at temperatures lower than 3000°F; 2) increasing gasifier carbon conversion; 3) increasing syngas production; 4) reducing steam consumption; 5) and increasing temperatures inside the gasifier without increasing oxygen consumption. *Specification*, p. 3, ll 1-8; p. 6, l. 11 to p. 7, l. 4. The high temperatures obtained by heating the throat will increase the carbon conversion of the gasifier by 0.1 to 3.0 percent, and decrease the steam requirement for the gasifier from approximately 0.25 to 0.35 pounds of steam per 1.0 pound of feedstock to approximately 0.15 to 0.25 pounds of steam per pound of feedstock.

Takada does not teach a temperature high enough or environment suitable to prevent solidification of slags containing vanadium trioxide (V_2O_3) or other metals that solidify at temperatures lower than 3000°F. *Takada* teaches an environment including a trough, which is not suggested to be any portion of a gasifier, and an operating temperature (1472°F) less than half of the minimum preferred (3000°F) by the description in the specification. Furthermore, the invention of *Takada* cannot achieve the other benefits mentioned above. Therefore, the teachings of *Takada* are insufficient to suggest the proposed modification to the prior art gasifier for its intended purpose. Under *In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984), "if [the] proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." MPEP § 2143.01.

b) No Reasonable Expectation of Success for the Proposed Modification

There is no reasonable expectation of success for making the modification because the *Takada* invention was intended for a trough open to ambient temperatures, while a gasifier is a much more harsh and dynamic environment. A reasonable expectation of success for making a modification is necessary in order to combine prior art references. MPEP § 2143.02; *In re Merck & Co., Inc.*, 800 F.2d 1091 (Fed. Cir. 1986). There is no suggestion in *Takada* that the materials used for the refractory (surface layer) or heating element, nor the construction of the trough as the trough is intended to be used, are satisfactory for the intended purposes of the present invention. Moreover, it is reasonable to assume that *Takada* discloses a heated trough including a heating element that is not satisfactory for use in a gasifier environment having temperatures two times as high as those described in *Takada*. Therefore, there is no reasonable expectation of success in modifying the prior art gasifier using the teachings of *Takada*.

2. Claims 37-40

Applicant submits that, with respect to claims 37-40, the Examiner has failed to make out a *prima facie* case for obviousness for the additional reason that the prior art does not teach all of the claimed limitations. Claim 37 recites a gasifier throat including "an electrical heating element between said inner and outer surfaces wherein said heating element is configured to maintain said inner surface at a temperature of at least 3000°F." As previously stressed, none of the cited art (*Takada* and Admitted Prior Art) teaches maintaining a surface at a temperature of at least 3000°F, nor does the art teach a heating element configured to maintain said surface at said temperature. As also mentioned before, this high temperature, undisclosed by *Takada*, is critical to addressing those concerns presented by slags containing vanadium trioxide (V_2O_3) or other metals, as well as increasing the production capabilities and efficiencies of the gasifier. Consequently, Applicant presented claims 37-40 to more narrowly claim a gasifier that is beyond the scope of

anything taught by the cited art. As previously mentioned, *Takada* merely teaches heating slag up to a temperature less than half of 3000°F, and only teaches heating slags that do not contain vanadium trioxide and other such metal compounds.

For the reasons stated above, Applicant respectfully submits that the Examiner's first ground of rejection be withdrawn, and respectfully requests that claims 10, 15, 17-20, 34 and 37-40 be allowed.

B. Second Ground of Rejection: in Further View of *Haneda*

Claims 31, 32 and 35 were rejected based on the previously addressed first ground of rejection, and in further view of *Haneda*. Because Applicant believes Admitted Prior Art and *Takada* cannot be combined, Applicant also believes this combination in further view of *Haneda* must also be withdrawn regarding these claims, and the claims allowed.

VIII. CONCLUSION

For the reasons stated above, Applicant respectfully submits that the Examiner erred in rejecting all pending claims. If any fees or time extensions are inadvertently omitted or if any fees have been overpaid, please appropriately charge or credit those fees to Conley Rose, P.C. Deposit Account Number 03-2769 (Atty. Docket No. 1927-00101) and enter any time extension(s) necessary to prevent this case from being abandoned.

Respectfully submitted,



Collin A. Rose
PTO Reg. No. 47,036
CONLEY ROSE, P.C.
(713) 238-8000 (Phone)
(713) 238-8008 (Fax)
ATTORNEY FOR APPLICANT

APPENDIX A
CLAIMS APPENDIX

1 – 9. (Cancelled)

10. (Previously presented) A quench gasifier for gasifying ash-containing hydrocarbon feedstocks, comprising:

- a combustion chamber for partially oxidizing carbon in the feedstocks to produce synthesis gases; and

- a quench chamber adjacent to said combustion chamber, said combustion chamber including a throat adjacent to said quench chamber for directing said gases from said combustion chamber to said quench chamber, characterized in that said throat includes:

- an inlet adjacent to said combustion chamber, said inlet having an inlet diameter;

- an outlet adjacent to said quench chamber, said outlet having an outlet diameter;

- an inner surface and outer surface between said inlet and said outlet;

- an electrical heating element between said inner and outer surfaces; and

- wherein said inlet diameter is greater than said outlet diameter.

11 - 14. (Cancelled)

15. (Previously Presented) The quench gasifier according to claim 10 wherein said inner surface comprises a wind tunnel profile.

16. (Cancelled)

17. (Previously Presented) The quench gasifier according to claim 10 wherein the ratio of said inlet diameter to said outlet diameter is at least 3.

18. (Previously Presented) The quench gasifier according to claim 17 wherein said ratio is in the range from 3 to 6.

19. (Previously Presented) The quench gasifier according to claim 10 wherein said quench chamber comprises a quench ring substantially axially adjacent to said throat outlet, such that the quench gasifier does not include a plenum chamber.

20. (Previously Presented) The quench gasifier according to claim 19 wherein said quench ring has an inner diameter that is greater than the diameter of said throat outlet.

21. (Cancelled)

22. (Withdrawn) A method for gasifying ash-containing hydrocarbon feedstocks comprising:

partially oxidizing the feedstock by mixing a feed stream, the feed stream comprising an oxidant, said feedstock, and a temperature moderator, in a combustion chamber comprising a reaction zone under conditions sufficient to produce synthesis gases with a predetermined carbon conversion rate, said conditions including a temperature of about 2000 – 3000°F; and

electrically heating a portion of the combustion chamber to a temperature elevated above 3000 °F.

23. (Withdrawn) The method of claim 22 wherein said oxidant is oxygen and wherein the synthesis gas production is increased without increasing the consumption of the oxygen.

24. (Withdrawn) The method of claim 22 wherein the synthesis gas production is increased without increasing the consumption of the feedstock.
25. (Withdrawn) The method of claim 22 wherein the temperature moderator is steam.
26. (Withdrawn) The method of claim 22 wherein the temperature moderator is carbon dioxide.
27. (Withdrawn) The method of claim 22 wherein the electrical heating comprises exposing said chamber portion to electromagnetic radiation.
28. (Withdrawn) The method of claim 22 wherein the electrical heating comprises applying electrical current to a resistor that is adjacent to said chamber portion.
29. (Withdrawn) The method of claim 22 wherein said portion includes substantially the entire hot face of the combustion chamber, such that the feed stream is preheated electrically, eliminating the use of a preheat burner.
30. (Cancelled)
31. (Previously Presented) The quench gasifier according to claim 10 wherein said heating element extends from said outlet to said inlet.
32. (Previously Presented) The quench gasifier according to claim 31 wherein said heating element is a spirally wound member having a first diameter near said throat inlet and a second diameter near said throat outlet, and wherein said first diameter is greater than said second diameter.

33. (Cancelled)

34. (Previously Presented) A quench gasifier for gasifying hydrocarbon feedstocks, comprising:

- a combustion chamber for partially oxidizing the carbon in the feedstocks to produce synthesis gases and slag;

- a quench chamber adjacent to said combustion chamber, said quench chamber having a gas outlet for directing said gases away from said quench chamber; and

- wherein said combustion chamber includes a throat for directing said gases and said slag from said combustion chamber to said quench chamber, said throat comprising:

- an inlet;

- an outlet;

- an outer surface between said inlet and said outlet;

- an inner surface between said inlet and said outlet;

- a heating element between said inner and outer surfaces; and

- wherein said inner surface has a curved, conical contour.

35. (Previously Presented) The quench gasifier according to claim 34 wherein said heating element is near said inner surface such that said heating element substantially follows said curved, conical contour of said inner surface.

36. (Cancelled)

37. (Previously Presented) A quench gasifier for gasifying ash-containing hydrocarbon feedstocks, comprising:

- a combustion chamber for partially oxidizing carbon in the feedstocks to produce synthesis gases; and

a quench chamber adjacent to said combustion chamber, said combustion chamber including a throat adjacent to said quench chamber for directing said gases from said combustion chamber to said quench chamber, characterized in that said throat includes:

an inlet adjacent to said combustion chamber, said inlet having an inlet diameter;

an outlet adjacent to said quench chamber, said outlet having an outlet diameter;

an inner surface and outer surface between said inlet and said outlet; and

an electrical heating element between said inner and outer surfaces wherein said heating element is configured to maintain said inner surface at a temperature of at least 3000°F.

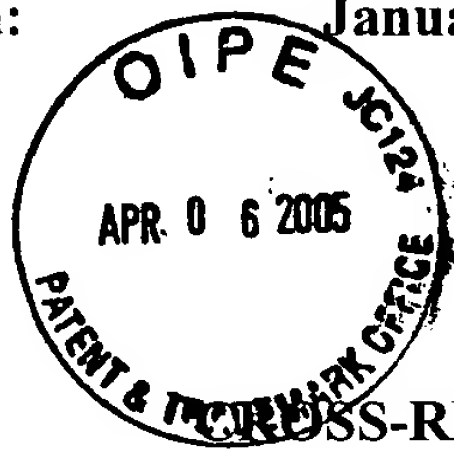
38. (Previously Presented) The quench gasifier according to claim 37 wherein the feedstocks include metal compounds such as vanadium trioxide, and wherein the feedstocks are substantially free of solidified metal compounds.

39. (Previously Presented) The quench gasifier according to claim 37 wherein said heated inner surface causes the partially oxidized carbon in the feedstocks to increase in the range of 0.1 to 3.0 percent.

40. (Previously Presented) The quench gasifier according to claim 37 wherein said heated inner surface causes a steam consumption rate in the range of 0.15 to 0.25 pounds of steam per pound of feedstocks.

APPEAL BRIEF APPENDIX “B”

Serial No.: 09/482,023
Filed: January 13, 2000



Clean Copy of Post-Amendment Specification

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

5 The present application claims the benefit of U.S. Provisional Application Serial No. 60/162,959, filed November 2, 1999, entitled Combustion Chamber Design for a Quench Gasifier, which is hereby incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

10 Not applicable.

REFERENCE TO A MICROFICHE APPENDIX

Not applicable.

BACKGROUND OF THE INVENTION

15 Quench gasifiers are used to gasify ash containing hydrocarbon feedstocks such as residual oils, waste lubrication oils, petroleum cokes and coal. A typical quench gasifier design is shown in Figure 1 (Reference: U.S. Patent No. 4,828,579). The feedstock, the oxidant and a temperature moderator (either steam or carbon dioxide) are injected into the top portion of the gasifier through a burner and are mixed with one another in the reaction zone below the burner. Steam and carbon
20 dioxide (CO₂) moderate the temperatures in the reaction zone and also act as reactants. The partial oxidation reactions that take place in this portion of the gasifier, called the combustion chamber, maintain the combustion chamber temperatures in the 2000 to 3000 °F range. The combustion chamber is lined with refractory materials such as alumina. Approximately 90.0 to 99.5 percent of the carbon in the feedstock is converted to the synthesis gases (syngas).

25 The bottom portion of the quench gasifier, called the quench chamber, is separated from the combustion chamber by the floor of the combustion chamber as shown in Figure 1. The

combustion chamber has an internal longitudinal length L_1 , an external longitudinal length L_2 , and an internal diameter D_1 . A portion of the floor of the combustion chamber forms a constricted gasifier throat having an internal diameter D_2 . The quench chamber is partially filled with water and is not lined with refractory. The quench chamber consists of three main components: the quench ring, the dip tube and the draft tube as shown in Figure 1. The main functions of the quench chamber are to cool down the synthesis gases generated in the combustion chamber by mixing them with water and to saturate the gases with water vapor.

The constricted gasifier throat area which directs the gases from the combustion chamber to the quench chamber is normally the coolest portion of the combustion chamber because of its distance from the gasifier burner and the burner flame. This area tends to be cooler than the rest of the combustion chamber also due to its proximity to the quench ring through which cooling water is injected into the quench chamber. As a result, the ash in the feedstock, which is in its molten or semi-molten form in the center portion of the combustion chamber, tends to solidify and form deposits or plugs in the throat area of the gasifier. These deposits are more likely to form with feedstocks that contain metal compounds such as vanadium trioxide (V_2O_3) because these compounds solidify at temperatures lower than 3000 °F. In addition to causing shutdown of the gasifier, these compounds also react and damage the alumina type refractories that have been used in existing gasifiers (see U.S. Patent No. 5,464,592).

A new gasifier throat design is proposed in this invention to avoid ash deposits and plugging in the throat area of the gasifier and to avoid damage to the refractories in the throat area. The proposed design will use electrical resistor heating to achieve temperatures in the range of 3000 to 3500 °F. The new design will also use refractory materials like silicon carbide and silicon nitride that can withstand higher temperatures and larger temperature shocks than alumina. With

this new design, it will be possible to increase the gasifier carbon conversion, reduce the steam (moderator) consumption and reduce the frequent damages that have been experienced to the refractories in the throat area of existing gasifiers. The proposed design will also decrease the capital cost of oil gasification plants by eliminating the need for soot recycle system downstream
5 and will reduce the plant operating cost by improving the reliability of the gasifier operations.

BRIEF SUMMARY OF THE INVENTION

Electrical heating and new refractory materials are proposed for the gasifier throat area, which will increase the throat area operating temperatures without increasing oxygen consumption. The high temperatures will improve the gasification process by increasing carbon conversion,
10 reducing steam or CO₂ consumption and by eliminating ash deposits and plugging. The preferred shape for the gasifier throat with electrical heating is the wind tunnel shape proposed in the previous U.S. Patent No. 4,574,002. The gasifier throat area is heated electrically using graphite resistors to maintain temperatures in the throat area between 3000 and 3500 °F. At these temperatures, higher carbon conversion is achieved and ash deposits are melted and pushed out of
15 the throat area by high syngas velocities achieved in the constricted throat area. The throat area refractories consist of three layers. The innermost layer or hot face that is exposed to the hot gases consists of silicon carbide or silicon nitride or a combination of the two materials. The middle layer consists of graphite resistors and the outermost layer consists of insulating refractories.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Figure 1: Prior Art Example 1, Typical Quench Gasifier Design with Conical or Funnel Shape Throat.

Figure 2: Prior Art Example 2, Typical Quench Gasifier Design with Wind Tunnel Shape Throat.

Figure 3: New Art Example, New Quench Gasifier Design with Electric Heating of the Throat Area.

Figure 4: Details of the New Throat Design.

Figure 5: New Combination Quench Gasifier.

5 **DETAILED DESCRIPTION OF THE INVENTION**

A previous patent (U.S. Patent Number 4,574,002) suggests changing the shape of the gasifier throat to avoid ash deposits and plugs in this area. The wind tunnel shape proposed in U.S. Patent No. 4,574,002 is shown in Figure 2. The combustion chamber again has an external longitudinal length L_2 and an internal diameter D_1 . However, the modified gasifier throat causes
10 the internal longitudinal length L_3 to decrease compared to the length L_1 of Figure 1. Additionally, the modified gasifier throat has an internal diameter D_3 . This shape provides a better chance of avoiding deposits and plugs in the throat area than the shape shown in Figure 1. However, the wind tunnel shape is also susceptible to deposits and plugs particularly when feedstock contains metals or metal compounds that solidify at temperatures lower than 3000 °F due to the distance of
15 the throat from the burner and its proximity to the quench ring component of the gasifier.

In order to avoid ash deposits and plugs in the throat area, particularly with feedstocks that contain vanadium trioxide type metal compounds, it is necessary to maintain temperatures in the throat area in the 3000 to 3500 °F. At these higher temperatures, vanadium oxide type compounds (vanadium trioxide and all other metal compounds that melt and flow easily at temperatures in the
20 3000 to 3500 °F range) will melt and easily flow out of the throat and into the quench chamber. The throat refractory will have to withstand these high temperatures. Alumina type refractories that have been used in the throat area in the past are frequently damaged by vanadium oxide type compounds (see U.S. Patent No. 5,464,592).

This patent application proposes electrical heating (either with resistors or with electromagnetic waves) of the throat area to avoid low temperatures in the throat area. This patent application also proposes that the hot face of the throat area refractory be silicon carbide, silicon nitride or a combination of the two. As shown in Figure 4, the electrical heating elements will be made of graphite and graphite heating elements will be used behind the hot face material. The outermost layer of the throat block will be made of insulating refractory. This insulating refractory will prevent high temperature exposure of the combustion chamber floor and the quench ring.

This new design will make it possible to control temperatures in any desired range in the throat area up to an upper temperature limit of about 3500 °F. The design proposed in Figure 3 shows an approximate wind tunnel shape, and a combustion chamber having an internal diameter D_1 and a modified gasifier throat having an internal diameter D_4 . The throat does not have to be exactly in the wind tunnel shape. The essential features of this design are that the ratio D_1/D_4 be in the range of 3 to 6 and that the diameter of the throat shape should decrease as you move away from D_1 portion of the throat.

Figure 3 only shows an application for the electrical heating concept in the throat area of a vertical quench gasifier. In fact, this concept can also be applied to a horizontal reactor as shown in Figure 5 or to the entire hot face of the combustion chamber. This concept can also be applied to any extension of the gasifier exit area such as the transition block area of Figure 5.

Figure 5 shows a combination quench gasifier. A portion of the syngas generated in the combustion chamber is quenched in water and the remaining syngas is quenched (cooled down) by injecting a cold quench gas.

The new combustion chamber throat design, shown in Figure 3 and Figure 4, will be more successful in preventing plugging in the throat area. This design will also eliminate the frequent

damages that have occurred to the throat refractory, because silicon carbide and silicon nitride can withstand higher temperatures and the erosive and corrosive effects of vanadium oxide type compounds better than alumina.

5 This patent suggestion also proposes eliminating the plenum chamber area shown in Figure 2. The quench ring area of the traditional quench gasifier is prone to frequent damage (References: U.S. Patent No. 4,828,580 and Patent No. 4,828,579). This new design (shown in Figure 3) will be more successful in preventing damage to the quench ring than the designs shown in Figures 1 and 2, because the distance between the throat opening and the quench ring is longer in the new design. Overall, this new design will improve the gasifier on-stream time (reliability of
10 operations) and thereby lower the gasifier operating cost.

The high temperatures obtained by electrical heating in the throat will also increase the gasification reaction rates and thereby increase the carbon conversion of the gasifier by 0.1 to 3.0 percent. This in turn will increase the syngas production of the gasifier without increasing either oxygen consumption or feedstock consumption.

15 The use of electrical heating and silicon carbide type refractories in the throat area will also reduce the consumption of the steam as a temperature moderator, because it will not be necessary to moderate the temperatures. Normally approximately 0.25 to 0.35 pound of steam is required for gasification of every 1.0 pound of residual oil or coke or coal. With this new design, the steam requirement will drop to 0.15 to 0.25 pound of steam per pound of feedstock.

20 Due to the increased carbon conversion achieved with this design, it will be possible to eliminate the soot recovery and soot recycle system that is normally employed downstream of the gasifier. Thus electrical heating of the throat area will reduce the gasification plant capital cost. The concept of electrical heating of the refractory can be extended to the entire gasifier hot face. If

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the entire hot face of the gasifier (not just the throat area) is electrically heated, it will be possible to preheat and cure the gasifier refractories electrically. There will be no need for using a preheat burner, a flue gas cooler and an aspirator (steam ejector) for preheating refractories. This will reduce the gasification plant capital cost further.

APPEAL BRIEF APPENDIX “C”

PTO: 2003-511

Japanese Published Unexamined (Kokai) Patent Application No. S61-222939, published October 3, 1986; Application No. S60-61803, filed March 28, 1985; Int. Cl.⁴: C93B 37/085; Inventor(s): Masayuki Takada et al.; Assignee: Nippon Steel Chemical Corporation; Japanese Title: Kanetsu Torafu (Heating Trough)

Specification

1. Title of Invention

Heating Trough

2. Claim

A heating trough, characterized by providing the following layers: a heat insulating layer in the inner surface of a substrate that forms the outer shape of the trough; a heat generating layer made of a fire retardant material with a heat generating element embedded in the inner surface of the heat insulating layer; a protective layer in the inner surface of the heat generating layer, which is in contact with a fused material stream.

3. Detailed Description of the Invention

[Field of Industrial Application]

This invention pertains to troughs for running a fused material stream (so-called slag) wherein the raw materials of mineral fibers such as rock wool are fused.

[Prior Art]

As for a conventional production of the mineral fibers, blast furnace slag or natural

rocks such as basalt and diabase are fused by using electric furnaces or the raw materials are mixed with coke, and the mixtures are fused in air blast fusion furnaces (cupolas). The slag is introduced into drafts making devices from tap holes via troughs so as to produce rock wool.

The troughs are designed in Fig.2 as follow. A substrate 1 whose cross-section is an L shape and whose interior is made of a hollow shell forms the outer shape. This inner hollow functions as a circulating circuit 6 for cooling water.

As for the trough with this structure, a large amount of a coating (so-called a slag coating) due to a coagulated substance is formed to the contact surface with the inner surface of the trough. When the slag coating is cleaned up, a slag lump is mixed into a rock wool product. If a coating occurs to the tip of the trough, a falling location of the slag inside the drafts making device displaces. The displacement of the falling location gives a significant effect on the quality of the product. This effect is critical with respect to the operation and the maintenance of the product quality.

[Problem of Prior Art to Be Addressed]

The present invention is produced to offer a trough with a structure to prevent a generation of the slag coating.

[Measures to Solve the Problem]

In order to eliminate the aforementioned disadvantage, the invention is as a heating trough, characterized by providing the following layers: a heat insulating layer in the inner

surface of a substrate that forms the outer shape of the trough; a heat generating layer made of a fire retardant material with a heat generating element embedded in the inner surface of the heat insulating layer; a protective layer in the inner surface of the heat generating layer, which is in contact with slag.

As the invention is described in detail with reference to the drawings, Fig.1 is a horizontal cross-sectional view illustrating a trough. A heat insulating layer 2 with a fire retardant heat insulating material such as a ceramic fiber lined in the inner surface of heat insulating iron substrate 1 is formed. A heat generating layer 3 with a kanthal wire (a Mo-Si heat generating element) heating element 5 embedded in the inner surface of heat insulating layer 2, such as a high alumina castable fire retardant material, is provided. A surface layer 4 that is brought into contact with slag is formed onto the upper surface of heat generating layer 3, more specifically the inner most surface, by using a heat and corrosion resistant material such as a carbon plate.

Other than the ceramic fiber, a silica fiber, an alumina fiber and a carbon fiber are used as fire retardant heat insulating materials for heat insulating layer 2. Other than the carbon plate, silicon carbide and high alumina are used as heat and corrosion resistant materials for surface layer 4.

[Effect]

According to the trough of the invention that has the aforementioned structure, by running current to heating element 5, surface layer 4 that is in contact with slag is maintained at a high temperature using a heat generated from heating element 5. Accordingly, the slag will

not solidify in the inner surface of the trough. No coating occurs. As a result, a slag lump will not flow into the drafts making device, and no coating occurs to the tip of the trough. The falling point of the slag in the drafts making device is stabilized. Subsequently, high quality rock wool can be produced.

Using the embodiment, the performance of the trough by the invention is described hereinbelow in detail.

[Embodiment]

Using a trough that comprises the following layers: ceramic fiber heat insulating layer 3 in the inner surface of iron substrate 1; heat generating layer 3 with kanthal wire heating element 5 embedded in an alumina castable fire retardant material; a carbon plate lined on the most inner section as surface layer 4, the surface temperature of the carbon plate, the temperature of the heater (heating element) and the shell temperature are measured, the table as shown below indicates a relationship among these temperatures.

Table (°C as the temperature unit)

Surface temperature	Heater temperature	Shell temperature
(Please refer to the original descriptions)		

At a testing that actually induces slag by the trough, the heater is heated to 1000°C in

advance 2 hours before slag is ejected from a cupola. After the ejection of the slag, an input to the eater is reduced as the temperature of the ejected slag gradually increases. The operation is finally performed at 800°C. As a result, no cleaning is required for 14 hours to remove a slag coating.

[Advantageous Result of the Invention]

As described above, according to the trough of the invention, the generation of a slag coating is prevented. Thus, a high quality mineral fiber is stably produced.

4. Brief Description of the Invention

Fig.1 is a horizontal cross-sectional view illustrating an example of a trough of the invention. Fig.2 is a horizontal cross-sectional view illustrating prior art trough.

1...Substrate

2...Heat insulating layer

3...Heat generating layer

4...Surface layer

5...Heater

Translations Branch
U.S. Patent and Trademark Office
11/13/02
Chisato Morohashi

APPEAL BRIEF APPENDIX “D”

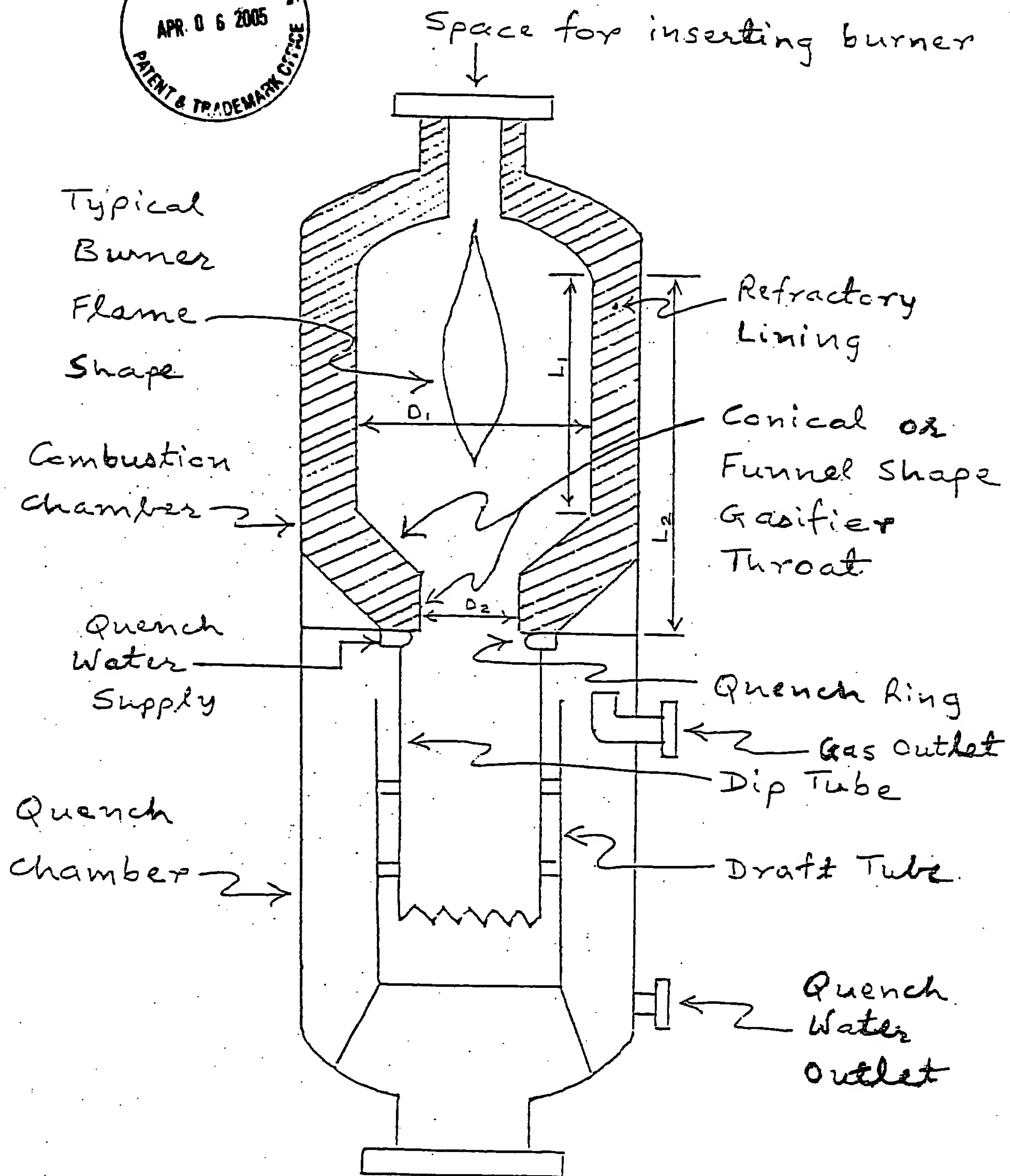
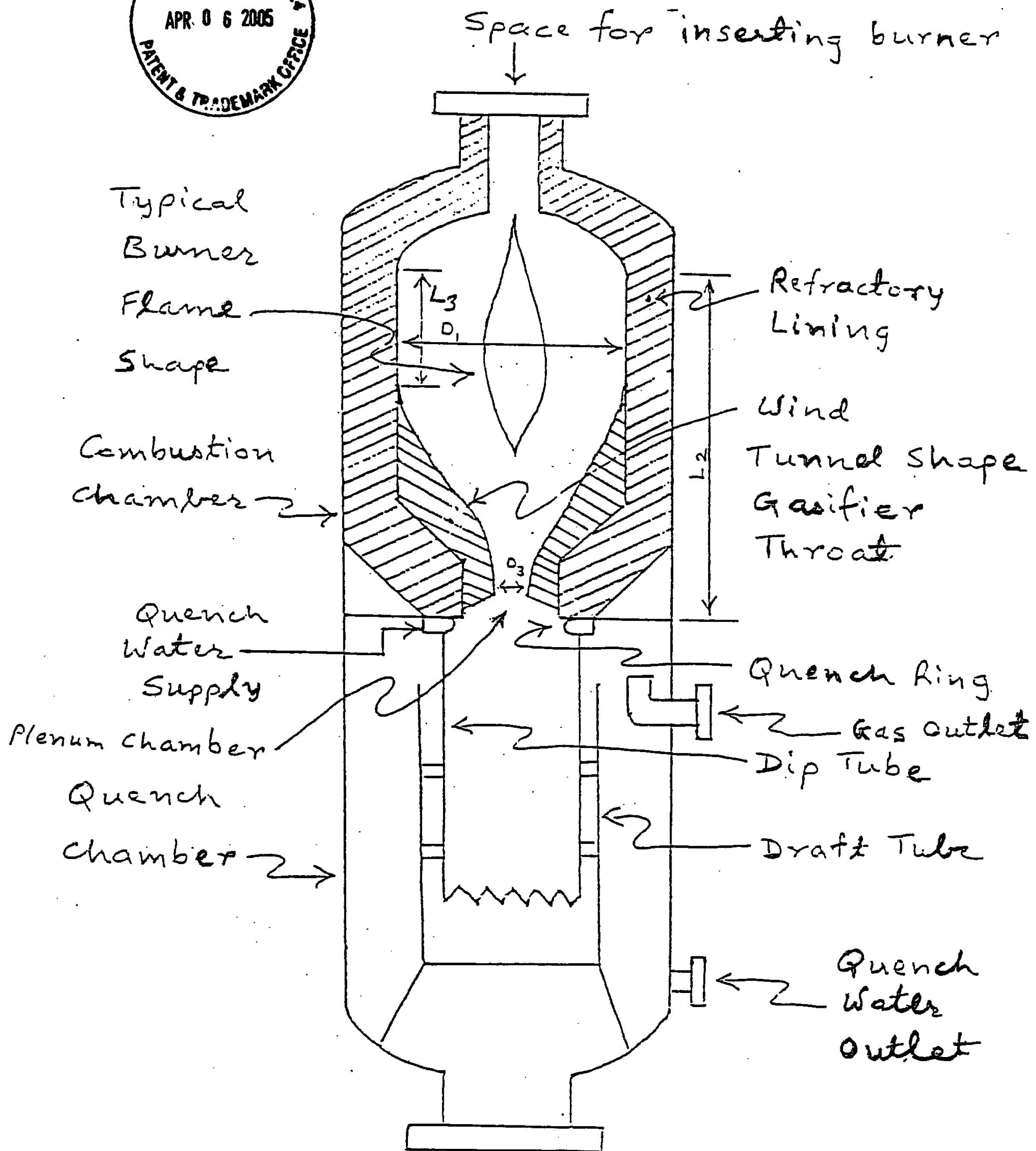


Figure 1 (Prior Art)



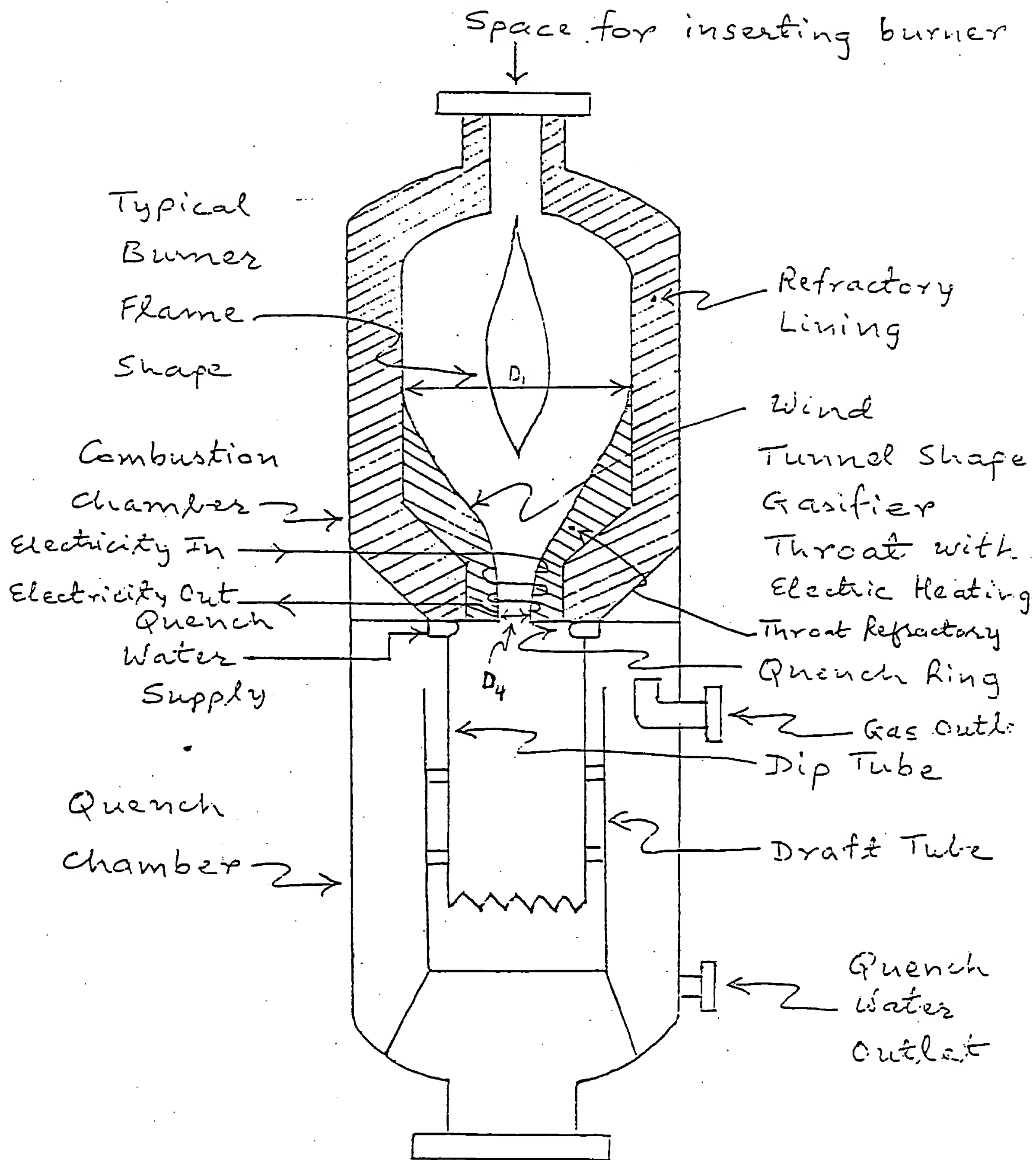
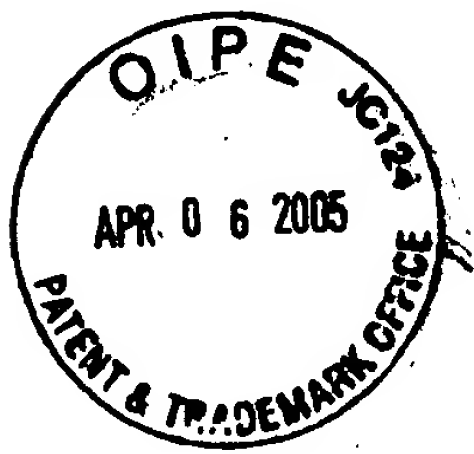


Figure 3

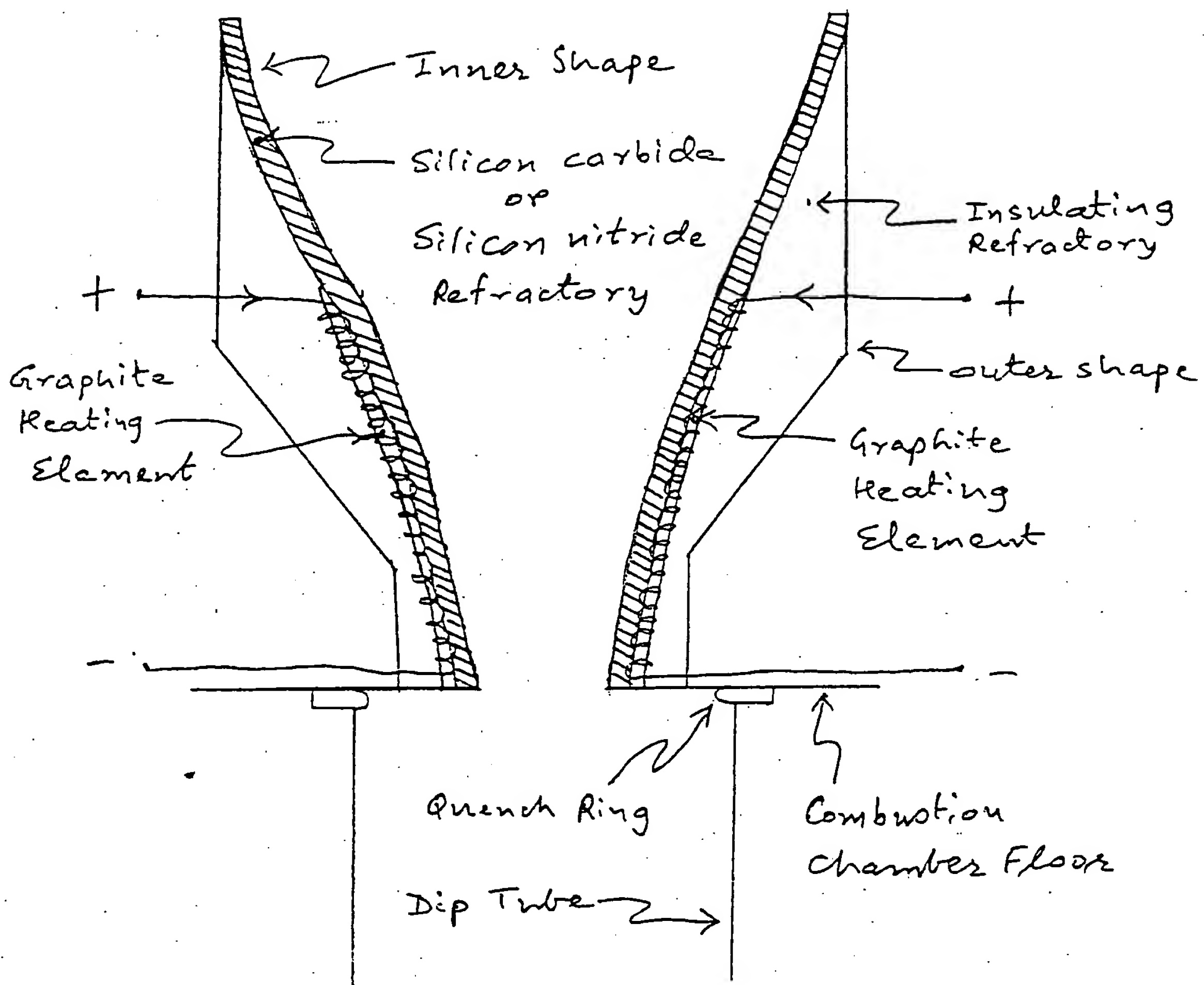


Figure 4

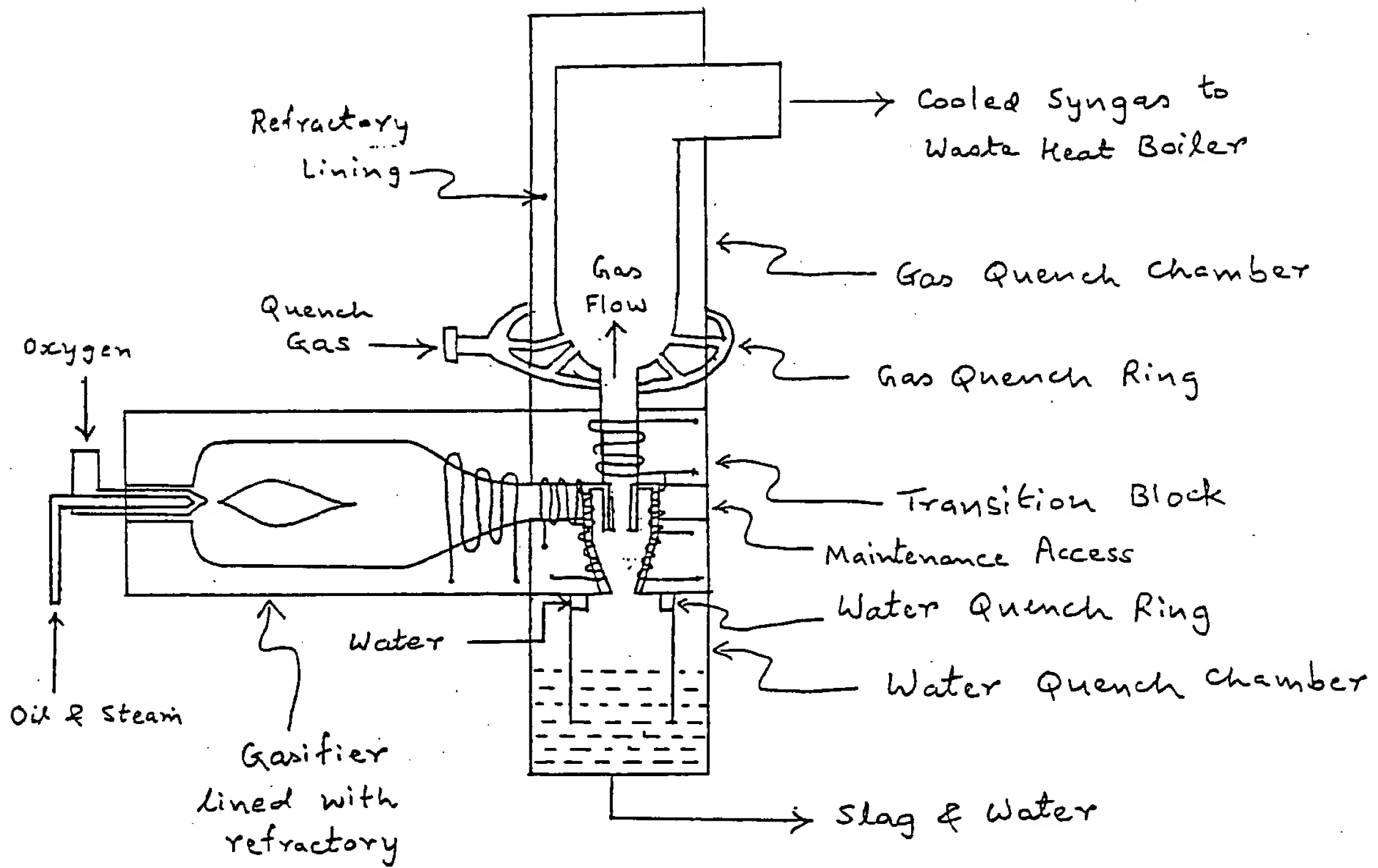


Figure 5